REMARKS

Preliminary Matters

As a preliminary matter and as discussed further below, no grounds are presented in the detailed portion of the present Office Action, i.e., the Office Action mailed 23 February 2005, for rejecting Claims 69 - 74 despite the indication on the first page of the Office Action that Claims 69 - 74 have been rejected. The present Office Action is incomplete under 37 CFR 1.104. The finality of the Office Action must be withdrawn.

Three self-evident grammatical errors have been corrected in Claims 37, 42, and 53. No other changes have been made to the claims. Accordingly, Claims 1 - 60 and 69 - 94 remain pending.

Rejection of Claims 1 - 5, 10 - 12, 29, 32, 33, 39, and 40

Claims 1 - 5, 10 - 12, 29, 32, 33, 39, and 40 have again been rejected under 35 USC 102(b) as anticipated by Sakai, U.S. Patent 4,529,994. This rejection is respectfully traversed.

The pertinent material of Sakai was summarized on page 26 of the Amendment submitted 11 June 2004 in response to the Office Action mailed 12 February 2004. That summary is, for convenience, repeated below:

> Sakai discloses, in Fig. 3, a varactor often referred to here as Sakai's "MIS varactor". Sakai's MIS varactor is created from n-type semiconductor body 11 having an upper horizontal surface, two slanted surfaces 20 that respectively meet the opposite edges of the upper horizontal surface, two vertical side surfaces, and a lower horizontal surface. P-type regions 14 and 15 are provided in n-type semiconductor body 11 respectively along slanted surfaces 20. Control electrodes 16 and 17 respectively contact p-type regions 14 and 15 along slanted surfaces 20. Bottom electrode 18 contacts the n-type material of semiconductor body 11 along the bottom horizontal surface. Capacitance reading electrode 25 is situated on insulating layer 24 provided along the upper horizontal surface.
>
> Item 19 in Fig. 3 of Sakai indicates a depletion layer that forms in the n-type material below insulating layer 24 along the p-n junctions between the n-type material and p-type regions 14 and 15. Although not shown in Fig. 3, depletion layer 19 presumably extends into p-type regions 14 and 15. The capacitive dielectric of Sakai's MIS varactor consists of depletion layer 19 and

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insulating layer 24. The capacitor plates consist of bottom electrode 18 and capacitance reading electrode 25.

Sakai applies a voltage between bottom electrode 18, on one hand, and control electrodes 16 and 17, on the other hand, sufficient to reverse bias the p-n junctions formed between the n-type material and p-type regions 14 and 15. The thickness of depletion layer 19 varies as a function of the reverse bias voltage. This causes the capacitance, as measured between capacitance reading electrode 25 and bottom electrode 18, to vary in a corresponding manner.

Except for the phrase "previously cited" which appears after "Sakai (US Patent 4,529,994)" in the first sentence of the present anticipation rejection of Claims 1 - 5, 10 - 12, 29, 32, 33, 39, and 40 based on Sakai, this rejection is identical to that made in the 12 February 2004 Office Action for rejecting Claims 1 - 5, 10 - 12, 29, 32, 33, 39, and 40 as anticipated by Sakai.

In the 11 June 2004 Amendment, Applicant's Attorney pointed out that Sakai lacks many of the features of independent Claim 1. Applicant's Attorney specifically pointed out there that Sakai fails to disclose each of the following limitations of Claim 1:

a. That there be an "inversion layer comprising multiple variably appearing inversion portions respectively characterized by corresponding different zero-point threshold voltages of like sign". The Examiner has analogized item 19 of Sakai to the recited inversion layer. As pointed out on pages 27 - 29 of the June 2004 Amendment, item 19 in Sakai is a depletion layer, not an inversion layer. As further pointed out on pages 29 and 30 of the June 2004 Amendment, even if Sakai's MIS varactor were operated under conditions that cause an inversion layer to form, the inversion layer would appear at substantially single instances of time and would disappear at substantially single instances of time. Such an inversion layer in Sakai's MIS varactor would not comprise multiple variably appearing inversion portions and thus would not have inversion portions characterized by different zero-point threshold voltages of like sign.

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b. That each inversion portion largely appear/disappear "when the gate-to-body voltage passes through the corresponding zero-point threshold voltage with the plate-to-body voltage at zero".

c. That each inversion portion meet the plate region or/and be "continuous with another inversion portion whose zero-point threshold voltage is of lower magnitude than the zero-point threshold voltage of that inversion portion".

d. That the "plate" electrode be one of the electrodes situated "in the capacitance signal path" of further electronic circuitry for enabling the further circuitry to perform an electronic function dependent on the recited varactor. The capacitance of Sakai's MIS varactor is taken between capacitance reading electrodes 25 and ohmic (opposite) electrode 18 respectively analogized by the Examiner to the "gate" and "body" electrodes of Claim 1. As pointed out on pages 30 and 31 of the June 2004 Amendment, control electrode 16 (or 17) analogized by the Examiner to the "plate" electrode of Claim 1 would therefore not be in the capacitance signal path of circuitry employing Sakai's MIS varactor.

The Examiner has presented nothing, absolutely nothing, to refute the arguments presented in the June 2004 Amendment (a) that the preceding differences exist between Sakai and the subject matter of Claim 1 and (b) that Sakai thus does not anticipate Claim 1.

In fact, the present Office Action does not even indicate that the Examiner has considered the remarks made in the June 2004 Amendment. On page 11 of the present Office Action in the section on "Response to Arguments", the Examiner only says that "Applicant's arguments filed on 11/23/04 with respect to the newly added claims 75-94 have been considered and are believed to be addressed in the above rejections with respect to those claims". By the reference to "Applicant's arguments filed on 11/23/04 with respect to the newly added claims 75-94", the Examiner presumably means the Supplemental Amendment submitted 23 November 2004 for adding Claims 75 - 94. The 23 November 2004 Supplemental Amendment briefly presented remarks for demonstrating the patentability of Claims 75 - 94 but did not repeat any earlier presented remarks, or add any new remarks, as to why Sakai does not anticipate Claim 1. Nowhere, not in the section on "Response to Arguments or elsewhere, does the present Office Action refer directly or indirectly to the June 2004 Amendment. Applicant's Attorney has no evidence to indicate that the Examiner has considered the remarks presented in the June 2004 Amendment to show why Claim 1 is not anticipated by Sakai.

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In any event, Sakai fails to anticipate Claim 1 for the reasons presented above[1]. The continued 35 USC 102(b) anticipation rejection of Claim 1 based on Sakai is clearly erroneous and must be withdrawn.

The capacitance of a capacitor such as a varactor depends, among other things, on the area of the capacitor plates. The capacitance increases as the plate area increases and vice versa. A key point of the invention of Claim 1 is that the inversion layer, which acts as an electrical conductor, forms part of one of the plates of the recited varactor. As the portions of the inversion layer variably appear and disappear, the plate area changes. This causes the capacitance of the varactor of Claim 1 to change.

Nowhere does Sakai disclose or suggest that the capacitance of any of Sakai's varactors could be adjusted by adjusting the area of an inversion layer. Depletion layer 19 in Sakai's MIS varactor is basically an insulator and does not form part or all of either of the plates of that varactor. Sakai does not disclose or suggest the key capacitance-adjusting point of Claim 1. For this reason, Claim 1 is not obvious in view of Sakai.

Reasons were also presented in the June 2004 Amendment as to why Sakai does not make the subject matter of Claim 1 obvious. Applicant's Attorney particularly stated on page 31 that:

> Nothing in Sakai would provide a person skilled in the art with any motivation or incentive for modifying Sakai's MIS varactor so that it produces an inversion layer consisting of multiple variably appearing inversion portions. Attempting to so modify Sakai's MIS varactor would not yield any improvement in varactor performance. In fact, the varactor would likely be degraded. Nor would there be any reason for reconfiguring Sakai's MIS varactor so that "plate" electrode 16 (or 17) and body electrode 18 are in the capacitance signal path of electronic circuitry that employs Sakai's MIS varactor.

As with the anticipation rejection of Claim 1 based on Sakai, the Examiner has presented absolutely nothing to refute the preceding arguments as to why Sakai does not make Claim 1 obvious. Hence, Claim 1 is patentable over Sakai.

As mentioned on page 31 of the June 2004 Amendment, Claims 2 - 5, 10 - 12, 29, 32, and 33 all depend (directly or indirectly) from Claim 1. Dependent Claims 2 - 5, 10 - 12, 29, 32, and 33 are therefore patentable over Sakai for the same reasons as Claim 1.

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[1] The full reasons presented in the June 2004 Amendment as to why Sakai does not anticipate Claim 1 are

Sakai also fails to disclose the further limitation of every one of dependent Claims 2 - 5, 10 - 12, 29, 32, and 33. The further subject matter recited in Claims 2 - 5, 10 - 12, 29, 32, and 33 makes them separately patentable over Sakai.

More particularly, Sakai fails to meet the further inversion-portion limitations of dependent Claims 2 - 5 because no inversion layer in any of Sakai's varactors comprises multiple variably appearing inversion portions. The allegations made by the Examiner on page 3 of the present Office Action in regard to Claims 2 - 5 are erroneous because item 19, parts of which are alleged by the Examiner to meet the further inversion-portion limitations of Claims 2 - 5, is again a depletion layer, not an inversion layer. Accordingly, Claims 2 - 5 are separately patentable over Sakai.

Dependent Claim 10 recites as its further limitation that "a surface depletion region of the body region extends along the gate dielectric layer below the gate electrode, the surface depletion region comprising multiple surface depletion portions of different respective average net dopant concentrations, each surface depletion portion situated below where a different corresponding one of the inversion portions occurs".

Depletion layer 19 in Sakai extends along "gate" electrode 25 in Sakai's MIS varactor and could arguably be viewed as consisting of multiple surface depletion portions. However, all such surface depletion portions would be of substantially the same average net dopant concentration. Sakai does not meet the requirement of Claim 10 that each surface depletion portion have a different average net dopant concentration that each other surface depletion portion. Applicant's Attorney further notes that the Examiner cannot properly analogize item 19 of Sakai to both the inversion and depletion layers of Claim 10 inasmuch as inversion and depletion layers are materially different in nature.

Additionally, Sakai fails to meet the limitation of Claim 10 that "each surface depletion portion" be "situated below where a different corresponding one of the inversion portions occurs" because, once again, Sakai lacks an inversion layer comprising multiple variably appearing inversion portions. Separate grounds are therefore provided for allowing Claim 10 over Sakai.

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The preceding grounds for separately allowing Claim 10 over Sakai apply to Claims 11 and 12 because they depend (directly or indirectly) from Claim 10. Sakai also fails to

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repeated later below.

meet the further requirement of each of Claims 11 and 12 in regard to particular recited different dopings in certain of the surface depletion portions. This is another reason why Claims 11 and 12 are separately patentable over Sakai.

Claim 32 recites as its further limitation that "the further circuitry maintains the gate-to-body voltage approximately constant as the plate-to-body voltage is varied".

Nowhere does the Examiner indicate how Sakai is believed to meet the further limitation of Claim 32. Taking note of the Examiner's analogies of electrodes 18, 25, and 16 of Sakai's MIS varactor respectively to the "body", "gate", and "plate" electrodes of the claims, Sakai does not disclose that the gate-to-body voltage, i.e., the voltage between "gate" electrode 25 and "body" electrode 18, of Sakai's MIS varactor is maintained approximately constant as its plate-to-body voltage, i.e., the voltage between "plate" electrode 16 (or 17) and "body" electrode 18, is varied. Accordingly, Sakai does not meet the requirement of Claim 32 that the gate-to-body voltage be maintained "approximately constant" as the plate-to-body voltage is varied. A separate basis is thus provided for allowing Claim 32 over Sakai.

Claim 33 recites as its further limitation that the varactor have a capacitance "measured between the plate and body electrodes" and that the structure include "an input circuit responsive to an input signal for generating the plate-to-body voltage such that the varactor's capacitance varies approximately linearly with the input signal". Claim 33 is particularly directed to input linearizer 270 illustrated in application Fig. 35 and described on pages 82 and 83 of the specification.

Nowhere does the Examiner indicate how Sakai is believed to meet the further limitation of Claim 33. Again noting the Examiner's analogies of electrodes 18, 25 and 16 respectively to the "body", "gate", and "plate" electrodes, the capacitance of Sakai's MIS varactor is measured between "gate" electrode 25 and "body" electrode 18 rather than between "plate" electrode 16 (or 17) and "body" electrode 18. Sakai thus fails to meet the requirement of Claim 33 that the varactor capacitance be "measured between the plate and body electrodes". This is one reason why Claim 33 is separately allowable over Sakai.

Sakai also fails to disclose any input linearizing circuitry responsive to an input signal for generating the voltage between "plate" electrode 16 (or 17) and "body" electrode 18 in such a way that the varactor's capacitance varies approximately linearly with the input signal.

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Accordingly, Sakai does not meet the requirement of Claim 33 that the structure include "an input circuit responsive to an input signal for generating the plate-to-body voltage such that the varactor's capacitance varies approximately linearly with the input signal". This is another reason why Claim 33 is separately allowable over Sakai.

Turning to independent Claim 39, Applicant's Attorney pointed out in the June 2004 Amendment that Sakai lacks certain features of Claim 39. Applicant's Attorney specifically pointed out there that Sakai fails to disclose each of the following limitations of Claim 39:

a. That the varactor in the claimed structure have a surface depletion region comprising "multiple surface depletion portions of different respective average net dopant concentrations" and that each surface depletion portion meet the plate region or/and be "continuous with a surface depletion portion more lightly doped than that surface depletion portion". Partially repeating what was said above in connection with Claim 10, item 19 of Sakai is a surface depletion layer that could arguably be viewed as consisting of multiple surface depletion portions. However, all such surface depletion portions would be of substantially the same average net dopant concentration. As specified on pages 31 and 32 of the June 2004 Amendment, Sakai does not disclose that each such surface depletion portion has a different average net dopant concentration that each other surface depletion portion.

b. That the "plate" electrode be one of the electrodes situated "in the capacitance signal path" of further electronic circuitry for enabling the further circuitry to perform an electronic function dependent on the recited varactor. For the reasons presented above in connection with Claim 1 and as explained on page 32 of the June 2004 Amendment, control electrode 16 (or 17) analogized by the Examiner to the "plate" electrode of Claim 39 would not be in the capacitance signal path of circuitry that employs Sakai's MIS varactor.

As is the case with Claim 1, the Examiner has presented absolutely nothing to refute the arguments presented in the June 2004 Amendment (a) that the preceding differences exist between Sakai and the subject matter of Claim 39 and (b) that Sakai therefore does not anticipate Claim 39. Once again, the present Office Action does not even indicate that the Examiner has considered the remarks made in the June 2004 Amendment

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Sakai fails to anticipate Claim 39 for the reasons presented above[2]. The continued anticipation rejection of Claim 39 based on Sakai is clearly erroneous and must be withdrawn.

Reasons were also presented in the June 2004 Amendment as to why Sakai does not make the subject matter of Claim 39 obvious. Applicant's Attorney particularly stated on pages 32 and 33 that:

> Nothing in Sakai would provide a person skilled in the art with any suggestion or motivation for modifying Sakai's MIS varactor so that the depletion section extending along insulating layer 24 below electrode 25 contains multiple surface depletion portions of different average net dopant concentrations. Modifying Sakai's MIS varactor in such a manner might degrade the varactor performance and, in any case, would not enhance the varactor performance.
>
> Furthermore, modifying Sakai's MIS varactor so that the surface depletion section extending along insulating layer 24 below electrode 25 consists of multiple surface depletion portions of different average net dopant concentrations would increase the fabrication complexity and attendant fabrication costs. Since the varactor performance would not be improved, there would be no economic justification for producing a varactor of greater complexity and higher cost. A person skilled in the art would have absolutely no reason for so modifying Sakai's varactor. Also, nothing in Sakai would provide a person skilled in the art with any motivation for reconfiguring Sakai's MIS varactor so that "plate" electrode 16 (or 17) and "body" electrode 18, rather than "gate" electrode 25 and "body" electrode 18, are in the capacitance signal path of electronic circuitry that utilizes Sakai's MIS varactor.

As with the anticipation rejection of Claim 39 based on Sakai, the Examiner has presented absolutely nothing to refute the preceding arguments as to why Sakai does not make Claim 39 obvious. Accordingly, Claim 39 is patentable over Sakai.

Claim 40 depends from Claim 39 and is therefore patentable over Sakai for the same reasons as Claim 39. Also, Sakai does not disclose or suggest the further limitation of Claim 40 in regard to particular recited different dopings in certain of the surface depletion portions. This provides separate grounds for allowing Claim 40 over Sakai.

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[2] The full reasons presented in the June 2004 Amendment as to why Sakai does not anticipate Claim 39 are repeated later below.

Rejection of Claims 6, 7 - 9, and 34 - 37

Claims 6, 7 - 9, and 34 - 37 have again been rejected under 35 USC 103(a) as obvious based on Sakai in view of Hattori, U.S. Patent Publication 2002/0036311 A1. This rejection is respectfully traversed.

The pertinent material of Hattori, as summarized on page 33 of the June 2004 Amendment, is repeated below:

Hattori discloses a power semiconductor device in which pinchoff is shifted away from a p-type base location near n^+ emitter 6 [sic, 7] to a p-type base location near n-type base 1 by making gate dielectric layer 3/10 thicker above the p-type base location near n-type base 1. According to Hattori, configuring gate dielectric layer 3/10 in this manner causes the collector-to-emitter voltage to be reduced so as to reduce the saturation current.

The present obviousness rejection of Claims 6, 7 - 9, and 34 - 37 based on Sakai and Hattori is identical to that made in the February 2004 Office Action for rejecting Claims 6, 7 - 9, and 34 - 37 as obvious based on Sakai and Hattori except for the phrase "previously cited" which appears after "Hattori" in the first sentence of this rejection.

On page 33 of the June 2004 Amendment, Applicant's Attorney noted the following about Claims 6, 7, and 34:

> Claim 6, which depends from Claim 1, recites that "the gate dielectric layer comprises multiple gate dielectric portions of different respective thicknesses" and that each gate dielectric portion is "situated above at least where a different corresponding one of the inversion portions occurs". Claim 7, which depends from Claim 6, recites that "each gate dielectric portion extends to a location above the plate region or/and is continuous with a gate dielectric portion thinner than that gate dielectric portion".
>
> Independent Claim 34 is directed to a structure containing a varactor in which a gate dielectric layer lies between a gate electrode and a body region. Similar to Claims 6 and 7, Claim 34 recites that the gate dielectric layer comprises "multiple gate dielectric portions of different respective thicknesses" and that each gate dielectric portion extends "to a location above the plate region or/and" is "continuous with a gate dielectric portion thinner than that gate dielectric portion".

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Taking note of the Examiner's statement on page 3 of the February 2004 Office Action that "Hattori discloses in figure 2, multiple gate dielectric portions 10, with different

thicknesses", Applicant's Attorney continued with the following remarks on pages 33 and 34 of the June 2004 Amendment:

> Hattori does indeed disclose a gate dielectric layer consisting of multiple portions of different thicknesses. However, absolutely nothing in Sakai and/or Hattori would provide a person skilled in the art with any suggestion or reason for configuring insulating layer 24 in Sakai's MIS varactor as multiple portions of different thicknesses. Inasmuch as Sakai lacks an inversion layer consisting of multiple variably appearing portions of different zero-point threshold voltages, Sakai has no need for a gate dielectric layer formed with multiple portions of different thicknesses.
>
> Modifying Sakai's insulating layer 24 so as to consist of multiple portions of different thicknesses would not cause Sakai's MIS varactor to perform better. In fact, so configuring Sakai's MIS varactor would likely cause the varactor performance to be degraded.
>
> Furthermore, modifying Sakai's MIS varactor so that insulating layer 24 consists of multiple portions of different thicknesses would increase the manufacturing complexity and cost. Without a performance improvement, such an increase in manufacturing complexity and cost would not be economically justifiable. Accordingly, a person skilled in the art would absolutely not apply the teachings of Hattori to Sakai in an effort to reach the subject matter of any of Claims 6, 7, and 34. Claims 6, 7, and 34 are thus patentable over Sakai and Hattori.

The Examiner has presented absolutely nothing to refute the preceding arguments, originally submitted in the June 2004 Amendment, for demonstrating the patentability of Claims 6, 7, and 34 over Sakai and Hattori. In light of the preceding arguments and the lack of anything that raises doubt about any of them, the continued obviousness rejection of Claims 6, 7, and 34 based on Sakai and Hattori is clearly erroneous and must be withdrawn.

Claim 9 depends from Claim 7. Claims 35 - 37 all depend (directly or indirectly) from Claim 34. Accordingly, dependent Claims 9 and 35 - 37 are patentable over Sakai and Hattori for the same reasons as Claims 6, 7, and 34.

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Claims 9 and 37 both recite that "each of at least two of the gate dielectric portions extends to a location above the plate region". Claim 36 depends from Claim 35. Taking note of the provision in Claim 35 that one of the two recited gate dielectric portions extends to "a location above the plate region", Claim 36 recites that "the gate dielectric portions include a third gate dielectric portion that extends to a location above the plate region". Hence, Claims 9, 36, and 37 each require that two or more gate dielectric portions extend to locations above

the plate region where each gate dielectric portion is of different thickness than each other gate dielectric portion.

Hattori discloses that the thick portion of gate dielectric layer 3/10 extends to a location above n^+ emitter (source) 7. However, no other portion of gate dielectric layer 3/10 extends to a location above n^+ emitter 7. Hattori does not meet the requirement of each of Claims 9, 36, and 37 that two or more gate dielectric portions of different thicknesses extend to locations above the plate region. Separate grounds are thus provided for allowing Claims 9, 36, and 37 over Sakai and Hattori.

Rejections of Claims 13, 17 - 21, 42, 44 - 46, 51 - 53, 57, and 58

Claims 13, 17, 18, 42, 44, 45, 53, 57, and 58 have again been rejected under 35 USC 103(a) as obvious based on Sakai in view of Tada, Japanese Patent Publication 4-199682. Claims 19 and 46 have again been rejected under 35 USC 103(a) as obvious based on Sakai and Tada in view of Iwamuro, U.S. Patent 5,659,185. Claims 20, 21, 51, and 52 have again been rejected under 35 USC 103(a) as obvious based on Sakai and Tada in view of Pramanick et al. ("Pramanick"), U.S. Patent 6,165,902. These rejections are respectfully traversed.

The pertinent material of Tada, Iwamuro, and Pramanick, as summarized on pages 34 and 35 of the June 2004 Amendment, is repeated below:

> Tada discloses a semiconductor device, apparently a transistor, in which top gate electrode 8 is electrically insulated from a bottom gate electrode consisting of p-type layer 4 and n-type layer 5 that meet each other to form a p-n junction. Bottom gate electrode 4/5 is electrically insulated from semiconductor substrate 1, specifically from doped layer 2 of substrate 1.
>
> Iwamuro discloses a thyristor in which a pair of gate electrodes 12 are electrically connected to each other. At col. 5, Iwamuro provides that gate electrodes 12 are deposited on gate oxide film 14. Although not explicitly stated in Iwamuro, electrodes 12 are presumably formed simultaneously and thus consist of substantially the same material, e.g., suitable metal or/and semiconductor material, such as polysilicon, doped with the same dopant to substantially the same average net dopant concentration.
>
> Pramanick discloses a field-effect transistor ("FET") having a polycrystalline gate electrode, presumably a gate electrode consisting of doped polycrystalline semiconductor material such as doped polysilicon.

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Except for the phrase "previously cited" which appears after "Japanese patent 04199682" in the first sentence of the present obviousness rejection of Claims 13, 17, 18, 42, 44, 45, 53, 57, and 58 based on Sakai and Tada, this rejection is identical to that made in the February 2004 Office Action for rejecting Claims 13, 17, 18, 42, 44, 45, 53, 57, and 58 as obvious based on Sakai and Tada. The present obviousness rejection of Claims 19 and 46 based on Sakai and Iwamuro is similarly identical to that made in the February 2004 Office Action for rejecting Claims 19 and 46 as obvious based on Sakai and Iwamuro except for the phrase "previously cited" which appears after "Iwamuro" in the first sentence of this rejection. Except for the phrase "previously cited" which appears after "Pramanick" in the first sentence of the present obviousness rejection of Claims 20, 21, 51, and 52 based on Sakai and Pramanick, this rejection is also identical to that made in the February 2004 Office Action for rejecting Claims 20, 21, 51, and 52 as obvious based on Sakai and Pramanick.

On page 35 of the June 2004 Amendment, Applicant's Attorney noted the following about Claims 13, 17 - 21, 42, 44 - 46, 51, and 52:

> Claim 13, which depends from Claim 1, recites that "the gate electrode comprises multiple gate electrode portions of doped semiconductor material" and that each gate electrode portion is "situated above at least where a different corresponding one of the inversion portions occurs". Claim 13 further recites that each gate electrode portion is "of a different conductivity type or/and a different average net dopant concentration than each other gate electrode portion".
>
> Independent Claim 42 is directed to a structure containing a varactor in which a gate electrode overlies a gate dielectric layer above a body region. Similar to Claim 13, Claim 42 recites that the gate electrode comprises "multiple gate electrodes portions of doped semiconductor material" and that each gate electrode portion is "of different conductivity type or/and different average net dopant concentration than each other gate electrode portion".
>
> Claims 17 - 21 all depend (directly or indirectly) from Claim 13. Claims 44 - 46, 51, and 52 all depend (directly or indirectly) from Claim 42. Accordingly, dependent Claims 17 - 21, 44 - 46, 51, and 52 all require that the gate electrode portions variously differ in conductivity type or/and average net dopant concentration.

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Applicant's Attorney then continued with the following remarks on pages 35 - 37 of the June 2004 Amendment:

> Tada does disclose a gate electrode formed with two portions of opposite, and thus different, conductivity types. However, absolutely nothing in Sakai, Tada, Iwamuro, and/or Pramanick would furnish a person skilled in

the art with any suggestion or motivation for configuring capacitance reading electrode 25 in Sakai's MIS varactor as two portions of different conductivity types. Since Sakai lacks an inversion layer consisting of multiple variably appearing portions of different zero-point threshold voltages, Sakai has no need for a gate electrode formed with two portions of different conductivity types.

Modifying capacitance reading electrode 25 in Sakai's MIS varactor so as to consist of two portions of different conductivity types would not improve the varactor performance. The performance of Sakai's MIS varactor would likely be degraded.

Additionally, modifying Sakai's MIS varactor such that capacitance reading electrode 25 consists of two portions of different conductivity types would increase the fabrication complexity and attendant cost. Due to the absence of a performance improvement, increasing the fabrication complexity and cost would not be economically justifiable. A person skilled in the art would absolutely not apply (a) the teachings of Tada to Sakai in an effort to reach the subject matter of any of Claims 13, 17, 18, 42, 44, and 45, (b) the teachings of Tada and Iwamuro to Sakai in an attempt to reach the subject matter of Claim 19 or 46, or (c) the teachings of Tada and Pramanick to Sakai in an effort to reach the subject matter of any of Claims 20, 21, 51, and 52. Claims 13, 17 - 21, 42, 44 - 46, 51, and 52 are thus variously patentable over Sakai, Tada, Iwamuro, and Pramanick.

Claims 19 and 46 respectively depend from Claims 17 and 44 which each recite that "the gate electrode portions comprise (a) a first gate electrode portion of opposite conductivity type to the body region and (b) a second gate electrode portion of the same conductivity type as the body region". Claims 19 and 46 each recite that "the gate electrode includes a metal-containing layer for electrically shorting the first and second gate electrode portions to each other". Accordingly, each of Claims 19 and 46 require that the metal-containing layer electrically short a pair of gate electrode portions of opposite conductivity types.

Opposite-conductivity-type portions 4 and 5 of the bottom gate electrode in Tada are not electrically shorted to each other. While Iwamuro discloses that gate electrodes 12 are electrically connected together, Iwamuro does not disclose that electrodes 12 consist of respective doped semiconductor regions of opposite conductivity types. Nor is there any grounds to believe that gate electrodes 12 in Iwamuro ould [sic, could] reasonably be of opposite conductivity types. Consequently, neither Tada nor Iwamuro discloses the further limitation of Claims 19 and 46 that the metal-containing layer electrically short a pair of gate electrode portions of opposite conductivity types. These differences establish a separate basis for allowing Claims 19 and 46 over Sakai, Tada, and Iwamuro.

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The Examiner has presented absolutely nothing to refute the preceding arguments, originally submitted in the June 2004 Amendment, for demonstrating the patentability of

Claims 13, 17 - 21, 42, 44 - 46, 51, and 52 variously over Sakai, Tada, Iwamuro, and Pramanick. In light of the preceding arguments and the lack of anything that raises doubt about any of them, the continued obviousness rejections of Claims 13, 17 - 21, 42, 44 - 46, 51, and 52 based variously on Sakai, Tada, Iwamuro, and Pramanick are clearly erroneous and must be withdrawn.

On page 37 of the June 2004 Amendment, Applicant's Attorney noted the following about independent Claim 53:

> Independent Claim 53 is directed to a varactor structure in which a gate electrode overlies a gate dielectric layer above a body region. Claim 53 requires that the gate electrode comprise "multiple gate electrode portions of doped semiconductor material". As amended, Claim 53 further requires that the gate electrode portions be "electrically shorted to one another", that each gate electrode portion be "continuous with at least one other of the gate electrode portions", and that each gate electrode portion be "of different conductivity type or/and different average net dopant concentration than each other gate electrode portion".

Applicant's Attorney then continued on page 37 of the June 2004 Amendment with the following remarks:

> As mentioned above, opposite-conductivity-type portions 4 and 5 of Tada's bottom gate electrode are not electrically shorted to each other. Tada fails to meet the limitation of Claim 53 that the gate electrode portions be "electrically shorted to one another". This limitation is, of course, also not met by Sakai. Even if there were some reason or suggestion for combining Sakai and Tada, the combination would not teach the full subject matter of Claim 53. Hence, Claim 53 is patentable over Sakai and Tada.
>
> Claims 57 and 58 both depend (directly or indirectly) from Claim 53 and are thus patentable over Sakai and Tada for the same reasons as Claim 53.

The Examiner has presented absolutely nothing to refute the preceding arguments, originally submitted in the June 2004 Amendment, for demonstrating the patentability of Claims 53, 57, and 58 over Sakai and Tada. In light of the preceding arguments and the lack of anything that raises doubt about any of them, the continued obviousness rejection of Claims 53, 57, and 58 based on Sakai and Tada is clearly erroneous and must be withdrawn.

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Rejection of Claims 14 - 16, 43, and 54 - 56

Claims 14 - 16, 43, and 54 - 56 have again been rejected under 35 USC 103(a) as obvious based on Sakai and Tada in view of Fratin et al. ("Fratin"), U.S. Patent 5,977,591. This rejection is respectfully traversed.

The pertinent material of Fratin, as summarized on page 37 of the June 2004 Amendment, is repeated below:

> Fratin discloses an FET whose source/drain regions are in a lightly doped drain configuration. Gate electrode 8 of Fratin's FET has mid-portion 13 which solely overlies channel region 7 and is of the same conductivity type as well (body region) 3. Gate electrode 8 has a pair of extensions 14 which are continuous with mid-portion 13 and which respectively extend over source/drain regions 4 and 5. Gate-electrode extensions 14 are either of opposite conductivity type to mid-portion 13 (and well 3) or of the same conductivity type as, but more lightly doped than, mid-portion 13.

The present obviousness rejection of Claims 14 - 16, 43, and 54 - 56 based on Sakai, Tada, and Fratin is identical to that made in the February 2004 Office Action for rejecting Claims 14 - 16, 43, and 54 - 56 as obvious based on Sakai, Tada, and Fratin except for the phrase "previously cited" which appears after "Fratin" in the first sentence of this rejection.

On page 37 of the June 2004 Amendment, Applicant's Attorney presented the following remarks about Claims 14 - 16, 43, and 54 - 56 in regard to Sakai, Tada, and Fratin:

> Claims 14, 43, and 54 which respectively depend from Claims 13, 42, and 53, each recite that "the gate electrode portions comprise first and second gate electrode portions of the same conductivity type and different average net dopant concentrations". Although extensions 14 of gate electrode 8 in Fratin are, in one embodiment, doped more lightly than mid-portion 13, absolutely nothing in Sakai, Tada, and/or Fratin would provide a person skilled in the art with any reason or motivation for configuring capacitance reading electrode 25 in Sakai's MIS varactor as multiple portions of the same conductivity type but different average net dopant concentrations. Inasmuch as Sakai lacks an inversion layer consisting of multiple variably appearing portions of different zero-point threshold voltages, Sakai has no need for a gate electrode formed with multiple portions of the same conductivity type but different average net dopant concentrations.
>
> Modifying Sakai's capacitance reading electrode 25 so as to consist of multiple portions of the same conductivity type but different average net dopant concentrations would not improve the performance of Sakai's MIS varactor. The varactor performance would likely be degraded.

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Modifying Sakai's MIS varactor so that capacitance reading electrode 25 consists of multiple portions of a same conductivity type but different average net dopant concentrations would also increase the manufacturing complexity and cost. Without a performance improvement, increasing the manufacturing complexity and cost would not be economically justifiable. A person skilled in the art would absolutely not apply the teachings of Tada and Fratin to Sakai in an effort reach the subject matter of any of Claims 14, 53, and 54. Accordingly, Claims 14, 43, and 54 are patentable over Sakai, Tada, and Fratin.

Claims 15 and 16 both depend from Claim 14. Claims 55 and 56 both depend from Claim 54. Hence, Claims 15, 16, 55, and 56 are patentable over Sakai, Tada, and Fratin for the same reasons as Claims 14 and 53.

The Examiner has presented absolutely nothing to refute the preceding arguments, originally submitted in the June 2004 Amendment, for demonstrating the patentability of Claims 14 - 16, 43, and 54 - 56 over Sakai, Tada, and Fratin. In light of the preceding arguments and the lack of anything that raises doubt about any of them, the continued obviousness rejection of Claims 14 - 16, 43, and 54 - 56 based on Sakai, Tada, and Fratin is clearly erroneous and must be withdrawn.

Rejections of Claims 22 - 27, 47 - 50, 59, and 60

Claims 22 - 24, 47 - 49, 59, and 60 have again been rejected under 35 USC 103(a) as obvious based on Sakai and Tada in view of Hattori. Claims 25 and 50 have again been rejected under 35 USC 103(a) as obvious based on Sakai, Tada, and Hattori in view of Iwamuro. Claims 26 and 27 have again been rejected under 35 USC 103(a) as obvious based on Sakai, Tada, and Hattori in view of Pramanick. These rejections are respectfully traversed.

The present obviousness rejection of Claims 22 - 24, 47 - 49, 59, and 60 based on Sakai, Tada, and Hattori is identical to that made in the February 2004 Office Action for rejecting Claims 22 - 24, 47 - 49, 59, and 60 as obvious based on Sakai, Tada, and Hattori. The present obviousness rejection of Claims 25 and 50 based Sakai, Tada, Hattori, and Iwamuro is likewise identical to that made in the February 2004 Office Action for rejecting Claims 26 and 27 as obvious based on Sakai, Tada, Hattori, and Iwamuro. The present obviousness rejection of Claims 26 and 27 based on Sakai, Tada, Hattori, and Pramanick is also identical to that made in the February 2004 Office Action for rejecting Claims 26 and 27 as obvious based on Sakai, Tada, Hattori, and Pramanick.

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On pages 39 and 40 of the June 2004 Amendment, Applicant's Attorney presented the following remarks about Claims 22 - 27, 47 - 50, 59, and 60 in regard to Sakai, Tada, Hattori, Iwamuro, and Pramanick:

> Claims 22, 47, and 59, which respectively depend from Claims 1, 42, and 53, are directed to embodiments, such as that of application Fig. 15, in which gate electrode portions of opposite conductivity types are combined with gate dielectric portions of different thicknesses. In particular, Claims 22, 47, and 59 each specify that "the gate dielectric layer comprises a first gate dielectric portion and a second gate dielectric portion thicker than the first gate dielectric portion", that "the gate electrode portions comprise (a) a first gate electrode portion" of doped semiconductor material "of opposite conductivity type to the body region and (b) a second gate electrode portion" of doped semiconductor material "of the same conductivity type as the body region", and that the first gate electrode portion overlies "the first and second gate dielectric portions".
>
> Claims 23 - 27 all depend from Claim 22. Claims 48 - 50 all depend from Claim 47. Claim 60 depends from Claim 59. As a result, dependent Claims 23 - 27, 48 - 50, and 60 all require that gate electrode portions of opposite conductivity types be combined with gate dielectric portions of different thicknesses.
>
> While (a) Tada discloses a gate electrode formed with portions of opposite conductivity types and (b) Hattori discloses a gate dielectric layer formed with portions of different thicknesses, absolutely nothing in Sakai, Tada, Hattori, or/and Pramanick would furnish a person skilled in the art with any suggestion or motivation (i) for configuring Sakai's capacitance reading (gate) electrode 25 as two portions of opposite conductivity types and (ii) for configuring Sakai's insulating (gate dielectric) layer 24 as two portions of different thicknesses. Since Sakai lacks an inversion layer consisting of multiple variably appearing portions of different zero-point threshold voltages, Sakai has no need for (i) a gate electrode formed with two portions of opposite conductivity types and/or (ii) a gate dielectric layer consisting of multiple portions of different thicknesses.
>
> Modifying (i) Sakai's capacitance reading electrode 25 to consist of two portions of opposite conductivity types and (ii) Sakai's insulating layer 24 to consist of two portions of different thicknesses would increase the fabrication complexity and cost without producing any performance improvement. The performance of a so-modified version of Sakai's MIS varactor would likely be degraded. Consequently, increasing the fabrication cost and complexity would not be economically justifiable. A person skilled in the art would absolutely not apply (a) the teachings of Tada and Hattori to Sakai in an effort to reach the subject matter of any of Claims 22 - 24, 47 - 49, 59, and 60, (b) the teachings of Hattori and Iwamuro to Sakai in an attempt to reach the subject matter of Claim 25 or 50, or (c) the teachings of Tada, Hattori, and Pramanick to Sakai in an effort to reach the subject matter of

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Claim 26 or 27. Claims 22 - 27, 47 - 50, 59, and 60 are thus variously patentable over Sakai, Tada, Hattori, Iwamuro, and Pramanick.

Claims 25 and 50 each require that the gate electrode include a metal-containing layer for electrically shorting two gate electrode portions of opposite conductivity types. Due to their dependence from amended Claim 53, Claims 59 and 60 similarly require that two gate electrode portions of opposite conductivity types be electrically shorted together. As indicated above, neither Tada nor Iwamuro discloses or suggests the electrical shorting of two gate electrode portions of opposite conductivity types. Even if there were some reasonable basis for combining Tada and possibly Iwamuro with Sakai and Hattori, the combination would not teach the full subject matter of any of Claims 25, 50, 59, and 60. This is a further reason why Claims 25 and 50 are patentable over Sakai, Tada, Hattori, and Iwamuro, and also a further reason why Claims 59 and 60 are patentable over Sakai, Tada, and Hattori.

The Examiner has presented absolutely nothing to refute the preceding arguments, originally submitted in the June 2004 Amendment, for demonstrating the patentability of Claims 22 - 27, 47 - 50, 59, and 60 variously over Sakai, Tada, Hattori, Iwamuro, and Pramanick. In light of the preceding arguments and the lack of anything that raises doubt about any of them, the continued obviousness rejections of Claims 22 - 27, 47 - 50, 59, and 60 based variously on Sakai, Tada, Hattori, Iwamuro, and Pramanick are clearly erroneous and must be withdrawn.

Rejections of Claims 28, 30, 31, 38, and 41

Claims 28, 31, 38, and 41 have again been rejected under 35 USC 103(a) as obvious based on Sakai and Hattori in view of Maszara et al. ("Maszara"), U.S. Patent Publication 2003/0178689 A1. Claim 30 has again been rejected under 35 USC 103(a) as obvious based on Sakai in view of Watanabe, U.S. Patent 4,003,009. These rejections are respectfully traversed.

The pertinent material of Maszara and Watanabe, as summarized on page 40 of the June 2004 Amendment, is repeated below:

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Maszara discloses an FET whose gate electrode is divided into two portions having different work functions.

Watanabe discloses a pair of electronic circuits in which an inductor, a resistor, and a varactor are arranged in series.

On pages 40 and 41 of the June 2004 Amendment, Applicant's Attorney presented the following remarks about Claims 28, 30, 31, 38, and 41 in regard to Sakai, Hattori, Maszara, and Watanabe:

> Claims 28, 30, and 31 all depend from Claim 1 and thus require an inversion layer comprising multiple portions of different zero-point threshold voltages of like sign. As pointed out above, Sakai does not meet this inversion-portion requirement. Accordingly, a person skilled in the art would have absolutely no reason for applying the teachings of Hattori, Maszara, or/and Watanabe to Sakai. Claims 28, 30, and 31 are thus variously patentable over Sakai, Hattori, Maszara, and Watanabe.
>
> Claims 38 and 41 respectively depend from independent Claims 34 and 39. Even if there were some motivation or suggestion for combining Maszara with Sakai and Hattori utilized in rejecting Claim 34, the combination of Sakai, Hattori, and Maszara would not make Claim 34 unpatentable. Since Claim 38 depends from Claim 34, Claim 38 is likewise patentable over Sakai, Hattori, and Maszara. Similarly, combining Maszara and Hattori with Sakai employed in rejecting Claim 39 would not make Claim 39 unpatentable even if there were some reason or incentive for combining Sakai, Hattori, and Maszara. Due to its dependence from Claim 39, Claim 41 is patentable over Sakai, Hattori, and Maszara.

The Examiner has presented absolutely nothing to refute the preceding arguments, originally submitted in the June 2004 Amendment, for demonstrating the patentability of Claims 28, 30, 31, 38, and 41 variously over Sakai, Hattori, Maszara, and Watanabe. In light of the preceding arguments and the lack of anything that raises doubt about any of them, the continued obviousness rejections of Claims 28, 30, 31, 38, and 41 based variously on Sakai, Hattori, Maszara, and Watanabe are clearly erroneous and must be withdrawn.

Additional Remarks About Claims 6 - 9, 13 - 28, 30, 31, 34 - 38, and 41 - 52

On page 41 of the June 2004 Amendment, Applicant's Attorney presented the following additional comments about Claims 6 - 9, 13 - 28, 30, 31, 34 - 38, and 41 - 52:

> Claims 6 - 9, 13 - 28, 30, 31, 34 - 38, and 41 - 52, all of which have been rejected under 35 USC 103(a) as obvious based on Sakai and one or more other references, are also patentable over the applied art for the following separate reasons. As mentioned above, independent Claims 1 and 39 each specify that the claimed structure includes "further electronic circuitry having a capacitance signal path for receiving the varactor to enable the further circuitry to perform an electronic function dependent on the varactor" and that "the plate and body electrodes" are "situated in the capacitance signal path". The same limitation is recited in each of independent Claims 34 and

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42. Claims 1, 34, 39, and 42 thus each require that the plate electrode be situated in the capacitance signal path of the electronic circuitry that employs the varactor recited in those claims.

As also mentioned above, Sakai measures the capacitance of its MIS varactor between capacitance reading electrode 25 and bottom electrode 18. Since the Examiner has analogized electrodes 25 and 18 respectively to the gate and body electrodes of the present claims, "gate" electrode 25 and "body" electrode 18 of Sakai's MIS varactor would be situated in the capacitance signal path of electronic circuitry which utilizes Sakai's MIS varactor.

Sakai's control electrode 16 (or 17) which the Examiner has analogized to the plate electrode of the present claims would not be situated in the electronic circuitry's capacitance signal path. The requirement of each of Claims 1, 34, 39, and 42 that the plate electrode be situated in the capacitance signal path of the further electronic circuitry which utilizes the recited varactor is thus not explicitly or inherently met in Sakai. For this reason, Claims 34 - 38 and 42 - 52 along with Claims 6 - 9, 13 - 28, 30, 31, and 41 which variously depend from Claims 1 and 39 are separately patentable over the applied art.

The Examiner has presented absolutely nothing to refute the preceding arguments, originally submitted in the June 2004 Amendment, for establishing separate grounds for allowing Claims 6 - 9, 13 - 28, 30, 31, 34 - 38, and 41 - 52. In light of the preceding arguments and the lack of anything that raises doubt about any of them, these separate grounds further show that the continued obviousness rejections of Claims 6 - 9, 13 - 28, 30, 31, 34 - 38, and 41 - 52 are clearly erroneous and must be withdrawn.

Lack of Grounds for Rejecting Claims 69 - 74

The cover sheet of the present Office Action indicates that Claims 69 - 74 have been rejected. However, the detailed portion of the Office Action presents no grounds for rejecting any of Claims 69 - 74.

37 CFR 1.104(b) provides, in pertinent part, that "The examiner's action will be complete as to all matters". 37 CFR 1.104(c)(2) further provides that:

> In rejecting claims for want of novelty or for obviousness, the examiner must cite the best references at his or her command. When a reference is complex or shows or describes inventions other than that claimed by the applicant, the particular part relied on must be designated as nearly as practicable. The pertinence of each reference, if not apparent, must be clearly explained and each rejected claim specified.

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The present Office Action is incomplete as to Claims 69 - 74. It is totally impermissible to reject a claim without presenting any basis for the rejection. The rejection of Claims 69 - 74 is fatally defective under 37 CFR 1.104.

On page 42 of the June 2004 Amendment, Applicant's Attorney presented the following remarks about Claims 69 - 74:

> New Claims 69 and 70 both depend (directly or indirectly) from Claim 53. Claim 69 requires that "the gate electrode includes a metal-containing layer for electrically shorting the first and second gate electrode portions to each other". Inasmuch as Sakai, Tada, and Iwamuro have been applied against dependent claims, such as Claim 19, which present this requirement, Claim 69 and its dependent Claim 70 are patentable over Sakai, Tada, and Iwamuro for the same reasons that Claim 53 is patentable over Sakai and Tada.
>
> New Claims 71 and 72 likewise both depend (directly or indirectly) from Claim 53. Claim 71 requires that "the doped semiconductor material of the gate electrode portions comprise doped non-monocrystalline semiconductor material". Since Sakai, Tada, and Pramanick have been applied against dependent claims, such as Claim 20, which recite this semiconductor material requirement, Claim 71 and its dependent Claim 72 are patentable over Sakai, Tada, and Pramanick for the same reasons that Claim 53 is patentable over Sakai and Tada.
>
> New Claims 73 and 74 depend (directly or indirectly) from Claim 59 and are patentable over Sakai, Tada, and Hattori for the same reasons as Claim 59.

In light of the preceding remarks originally presented in the June 2004 Amendment, Claims 69 - 74 are variously patentable over Sakai, Tada, Hattori, Iwamuro, and Pramanick.

Rejection of Claims 75 - 78 and 83 - 86

Claims 75 - 78 and 83 - 86 have been rejected under 35 USC 103(a) as obvious based on Sakai in view of Benaissa et al. ("Benaissa"), U.S. Patent Application Publication US 2002/0074589 A1. This rejection is respectfully traversed.

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Benaissa discloses a semiconductor varactor whose capacitive dielectric is formed with a "gate" dielectric layer sandwiched between a pair of plates respectively consisting of a "gate" electrode and an n-type semiconductor well region laterally surrounded by a dielectric isolation region formed with material such as silicon oxide or/and silicon nitride.

Claims 75 - 78 all depend (directly or indirectly) from independent Claim 1. Applicant's Attorney pointed out above that Sakai fails to disclose each of the following limitations of Claim 1:

a. That there be an "inversion layer comprising multiple variably appearing inversion portions respectively characterized by corresponding different zero-point threshold voltages of like sign";

b. That each inversion portion largely appear/disappear "when the gate-to-body voltage passes through the corresponding zero-point threshold voltage with the plate-to-body voltage at zero";

c. That each inversion portion meet the plate region or/and be "continuous with another inversion portion whose zero-point threshold voltage is of lower magnitude than the zero-point threshold voltage of that inversion portion"; and

d. That the "plate" electrode be one of the electrodes situated "in the capacitance signal path" of further electronic circuitry for enabling the further circuitry to perform an electronic function dependent on the recited varactor.

Benaissa does not disclose or suggest any of the preceding limitations of Claim 1. Even if there were some motivation or suggestion for combining Sakai and Benaissa, the combination of the two references would not teach the full subject matter of Claim 1. Consequently, the combination of Sakai and Benaissa would not teach the full subject matter of any of dependent Claims 75 - 78 even if it were reasonable to combine Sakai and Benaissa in the way proposed by the Examiner. Claims 75 - 78 are patentable over Sakai and Benaissa for the same reasons that Claim 1 is patentable over Sakai.

Similar comments apply to Claims 83 - 86 which all depend (directly or indirectly) from independent Claim 39. Applicant's Attorney pointed out above that Sakai fails to disclose both of the following limitations of Claim 39:

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a. That the varactor in the claimed structure have a surface depletion region comprising "multiple surface depletion portions of different respective average net dopant concentrations" and that each surface depletion portion meet the plate region or/and be "continuous with a surface depletion portion more lightly doped than that surface depletion portion"; and

b. That the "plate" electrode be one of the electrodes situated "in the capacitance signal path" of further electronic circuitry for enabling the further circuitry to perform an electronic function dependent on the recited varactor.

Benaissa does not disclose or suggest either of the preceding limitations of Claim 39. Even if there were some motivation or suggestion for combining Sakai and Benaissa, the combination of the two references would not teach the full subject matter of Claim 39. Consequently, the combination of Sakai and Benaissa would not teach the full subject matter of any of dependent Claims 83 - 86 even if it were reasonable to combine Sakai and Benaissa in the proposed manner. Claims 83 - 86 are patentable over Sakai and Benaissa for the same reasons that Claim 39 is patentable over Sakai.

On pages 9 and 10 of the present Office Action, the Examiner first notes that Fig. 4 of Benaissa discloses "a varactor structure with isolation structures 30 surrounding a semiconductor island laterally" and then alleges in connection with Claims 75 - 78 and 83 - 86 that "it would have been obvious to one of ordinary skill in the art at the time of the invention to include isolation trenches around the body region of the Sakai's varactor structure in order to insulate the regions of the device from the neighboring regions of the semiconductor devices which are present on a substrate, when the varactor is used in circuitry along with the other semiconductor devices". Independent of the previously mentioned reasons for which Claims 75 - 78 and 83 - 86 are patentable over Sakai and Benaissa, this allegation is erroneous.

Sakai does not disclose any applications for any of its varactors. However, in describing a varactor that is prior art to its varactors, Sakai states at the end of the Background of the Invention that "Additionally, with supply voltage of about 12 V, which is a standard voltage in a car, etc, the thickness of the depletion layer formed in accordance with the movement of carriers is also restricted". From the reference to the standard 12-V voltage for a car, one might infer that Sakai's varactors are discrete devices, each formed solely with one varactor structure or solely with multiple varactor structures arranged in a row as shown in Fig. 5c of Sakai. Such discrete devices would not include semiconductor devices other than Sakai's varactors.

In any event, the upper surface of the semiconductor body of each of Sakai's varactors has two sloped faces. The sloping faces along the upper semiconductor surface would make

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it difficult to form semiconductor devices other than Sakai's varactors from the semiconductor body. In other words, the nature of Sakai's varactor structure is generally unsuitable for forming other types of semiconductor devices from Sakai's semiconductor body. A person skilled in the semiconductor art would thus not be motivated to form other types of semiconductor devices from the semiconductor body used in each of Sakai's varactors. In the absence of other such semiconductor device, there would be no reason to laterally surround the semiconductor material of any of Sakai's varactors with a field insulation region as required in Claims 75 - 78 and 83 - 86.

It is not clear to Applicant's Attorney whether electrical insulation would be needed between individual varactors in Sakai's device in Fig. 5c where multiple varactor structures are arranged in a row. If lateral electrical insulation were used in the multiple-varactor structure of Fig. 5c, it would only be necessary to locate the insulation between each pair of varactors along the row of varactors. There would again be no reason to laterally surround the semiconductor material of any of Sakai's varactors with field insulation as required in Claims 75 - 78 and 83 - 86.

As far as Applicant's Attorney can determine, there are no obvious circumstances in which it would be desirable to apply the teachings of Benaissa to that of Sakai for modifying any of Sakai's varactors to laterally surround it with field insulation such as trench insulation. This is a separate reason why Claims 75 - 78 and 83 - 86 are patentable over Sakai and Benaissa.

Each of Claims 78 and 86 recite as its further limitation that "the body region substantially laterally surrounds the plate region". Neither Sakai nor Benaissa discloses or suggests this limitation. A separate basis is thereby provided for allowing Claims 78 and 86 over Sakai and Benaissa.

Rejection of Claims 79 - 82

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Claims 79 - 82 have been rejected under 35 USC 103(a) as obvious based on Sakai and Hattori in view of Benaissa. This rejection is respectfully traversed.

Claims 79 - 82 all depend (directly or indirectly) from independent Claim 34 which recites that the gate dielectric layer comprises "multiple gate dielectric portions of different respective thicknesses" and that each gate dielectric portion extends "to a location above the

plate region or/and" is "continuous with a gate dielectric portion thinner than that gate dielectric portion". Taking note of the fact that Hattori has a gate dielectric layer consisting of multiple portions of different thicknesses, Applicant's Attorney stated above that:

> [A]bsolutely nothing in Sakai and/or Hattori would provide a person skilled in the art with any suggestion or reason for configuring insulating layer 24 in Sakai's MIS varactor as multiple portions of different thicknesses. Inasmuch as Sakai lacks an inversion layer consisting of multiple variably appearing portions of different zero-point threshold voltages, Sakai has no need for a gate dielectric layer formed with multiple portions of different thicknesses.
>
> Modifying Sakai's insulating layer 24 so as to consist of multiple portions of different thicknesses would not cause Sakai's MIS varactor to perform better. In fact, so configuring Sakai's MIS varactor would likely cause the varactor performance to be degraded.
>
> Furthermore, modifying Sakai's MIS varactor so that insulating layer 24 consists of multiple portions of different thicknesses would increase the manufacturing complexity and cost. Without a performance improvement, such an increase in manufacturing complexity and cost would not be economically justifiable.

Applicant's Attorney then pointed out that "a person skilled in the art would absolutely not apply the teachings of Hattori to Sakai in an effort to reach the subject matter of" Claim 34 and that Claim 34 was therefore patentable over Sakai and Hattori.

As is the situation with Sakai and Hattori, nothing in Benaissa would provide a person skilled in the art with any suggestion or reason for configuring insulating layer 24 in Sakai's MIS varactor to consist of multiple portions of different thicknesses. Since Claims 79 - 82 depend from Claim 34, dependent Claims 79 - 82 are patentable over Sakai, Hattori, and Benaissa for the same reasons that Claim 34 is patentable over Sakai and Hattori.

On page 10 of the present Office Action, the Examiner alleges in connection with Claims 79 - 82 that Benaissa "discloses these limitations, as discussed above with respect to claims 75-78, and as to why one of ordinary skill in the art would want to use the trench insulators". The Examiner continues by stating that "that part of the rejection will not be repeated here".

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Presumably the Examiner is referring to the allegation on pages 9 and 10 of the present Office Action in connection with Claims 75 - 78 and 83 - 86 that "it would have been obvious to one of ordinary skill in the art at the time of the invention to include isolation trenches around the body region of the Sakai's varactor structure in order to insulate the

regions of the device from the neighboring regions of the semiconductor devices which are present on a substrate, when the varactor is used in circuitry along with the other semiconductor devices". If so, the comments presented above as to why that allegation is erroneous in connection with Claims 75 - 78 and 83 - 86 apply to Claims 79 - 82. For the reasons presented above in connection with Claims 75 - 78 and 83 - 86, there are no obvious circumstances in which it would be desirable to apply the teachings of Benaissa to that of Sakai for modifying any of Sakai's varactors to laterally surround it with field insulation such as trench insulation. This is a separate reason why Claims 79 - 82 are patentable over Sakai, Hattori, and Benaissa.

Claim 82 recites the same further limitation as Claims 78 and 86, namely that "the body region substantially laterally surrounds the plate region". Hattori does not disclose or suggest this limitation. Since neither Sakai nor Benaissa discloses or suggests this limitation, a separate basis is provided for allowing Claim 82 over Sakai, Hattori, and Benaissa.

Rejection of Claims 87 - 94

Claims 87 - 94 have been rejected under 35 USC 103(a) as obvious based on Sakai and Tada in view of Benaissa. This rejection is respectfully traversed.

Claims 87 - 90 all depend (directly or indirectly) from independent Claim 42 which recites that the gate electrode comprises "multiple gate electrodes portions of doped semiconductor material" and that each gate electrode portion is "of different conductivity type or/and different average net dopant concentration than each other gate electrode portion". Taking note of the fact that Tada has a gate electrode formed with two portions of opposite, and thus different, conductivity types, Applicant's Attorney stated above that "absolutely nothing" in Sakai and/or Tada "would furnish a person skilled in the art with any suggestion or motivation for configuring capacitance reading electrode 25 in Sakai's MIS varactor as two portions of different conductivity types" and that "Since Sakai lacks an inversion layer consisting of multiple variably appearing portions of different zero-point threshold voltages, Sakai has no need for a gate electrode formed with two portions of different conductivity types".

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Applicant's Attorney further stated above that:

> Modifying capacitance reading electrode 25 in Sakai's MIS varactor so as to consist of two portions of different conductivity types would not improve

the varactor performance. The performance of Sakai's MIS varactor would likely be degraded.

Additionally, modifying Sakai's MIS varactor such that capacitance reading electrode 25 consists of two portions of different conductivity types would increase the fabrication complexity and attendant cost. Due to the absence of a performance improvement, increasing the fabrication complexity and cost would not be economically justifiable.

Applicant's Attorney then pointed out that "A person skilled in the art would absolutely not apply" the teachings of Tada to Sakai in an effort to reach the subject matter of Claim 42 and that Claim 42 was therefore patentable over Tada and Sakai.

As is the situation with Sakai and Tada, nothing in Benaissa would furnish a person skilled in the art with any suggestion or motivation for configuring capacitance reading electrode 25 in Sakai's MIS varactor as two portions of different conductivity types. Because Claims 87 - 90 depend from Claim 42, dependent Claims 87 - 90 are patentable over Sakai, Tada, and Benaissa for the same reasons that Claim 34 is patentable over Sakai and Tada.

Claims 91 - 94 all depend (directly or indirectly) from independent Claim 53 which recites that the gate electrode comprise "multiple gate electrode portions of doped semiconductor material", that the gate electrode portions be "electrically shorted to one another", that each gate electrode portion be "continuous with at least one other of the gate electrode portions", and that each gate electrode portion be "of different conductivity type or/and different average net dopant concentration than each other gate electrode portion".

Taking note of the fact opposite-conductivity-type portions 4 and 5 of Tada's bottom gate electrode are not electrically shorted to each other, Applicant's Attorney pointed out above that both Tada and Sakai fail to meet the limitation of Claim 53 that the gate electrode portions be "electrically shorted to one another". Benaissa also fails to meet this limitation. Even if there were some reason or suggestion for combining Sakai, Tada, and Benaissa the combination would not teach the full subject matter of Claim 53. Accordingly, the combination of Sakai, Tada, and Benaissa would not teach the full subject matter of any of dependent Claims 91 - 94 even if it were reasonable to combine Sakai, Tada, and Benaissa in the manner proposed by the Examiner. Claims 91 - 94 are patentable over Sakai, Tada, and Benaissa for the same reasons that Claim 53 is patentable over Sakai and Tada.

On page 11 of the present Office Action, the Examiner alleges in connection with Claims 87 - 94 that Benaissa "discloses these limitations, as discussed above with respect to

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claims 75-78, and as to why one of ordinary skill in the art would want to use the trench insulators". The Examiner continues by stating that "that part of the rejection will not be repeated here".

Presumably the Examiner is again referring to the allegation on pages 9 and 10 of the present Office Action in connection with Claims 75 - 78 and 83 - 86 that "it would have been obvious to one of ordinary skill in the art at the time of the invention to include isolation trenches around the body region of the Sakai's varactor structure in order to insulate the regions of the device from the neighboring regions of the semiconductor devices which are present on a substrate, when the varactor is used in circuitry along with the other semiconductor devices". If so, the comments presented above as to why that allegation is erroneous in connection with Claims 75 - 78 and 83 - 86 apply to Claims 87 - 94. For the reasons presented above in connection with Claims 75 - 78 and 83 - 86, there are no obvious circumstances in which it would be desirable to apply the teachings of Benaissa to that of Sakai for modifying any of Sakai's varactors to laterally surround it with field insulation such as trench insulation. This is a separate reason why Claims 87 - 94 are patentable over Sakai, Tada, and Benaissa.

Claims 90 and 94 recite the same further limitation as Claims 78, 82, and 86, i.e., that "the body region substantially laterally surrounds the plate region". Tada does not disclose or suggest this limitation. Inasmuch as this limitation is not disclosed or suggested by Sakai or Benaissa, a separate basis is provided for allowing Claims 90 and 94 over Sakai, Tada, and Benaissa.

Further Remarks About Claims 1 and 39

Repeated below, for the Examiner's convenience, are the remarks presented on pages 27 - 31 of the June 2004 Amendment as to why Sakai does not anticipate Claim 1:

> Independent Claim 1 is directed to a structure containing a varactor in which an inversion layer occurs in a body region along a gate dielectric layer below a gate electrode. Claim 1 recites, in material part, that the inversion layer comprises "multiple variably appearing inversion portions respectively characterized by corresponding different zero-point threshold voltages of like sign", that each inversion portion largely appears/disappears "when the gate-to-body voltage passes through the corresponding zero-point threshold voltage with the plate-to-body voltage at zero", and that each inversion portion meets "the varactor's plate region or/and" is "continuous with another inversion

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portion whose zero-point threshold voltage is of lower magnitude than the zero-point threshold voltage of that inversion portion".

The Examiner alleges that Sakai discloses "an inversion layer 19 occurring in the body region along the gate dielectric layer below the gate electrode, the inversion layer comprising multiple variably appearing inversion portions (at the middle and the sides of region 19, where there are different thickness)". This is incorrect. Item 19 in Sakai is a depletion layer, not an inversion layer.

Depletion and inversion layers are two very different, basically opposite, semiconductor phenomena. A depletion layer is essentially an electrical insulator. This insulating characteristic enables a depletion layer to be used as capacitive dielectric in a capacitor or varactor. In contrast, an inversion layer is essentially an electrical conductor and is therefore unsuitable for use as capacitive dielectric.

To further understand the differences between inversion and depletion layers, it is helpful to briefly review certain basic semiconductor device physics. A piece of doped semiconductor material consists of neutral atoms of the semiconductor material, singly charged atoms of semiconductor dopant, and mobile charge carriers. The singly charged atoms of dopant are commonly referred to as bound charges because they are immobile. The bound charges are positively charged for n-type dopant formed with electron donor atoms. For p-type dopant formed with electron acceptor atoms, the bound charges are negatively charged.

The mobile charge carriers consist of negatively charged electrons and positively charged holes (basically the absence of electrons). The mobile charge carriers are further classified as majority charge carriers and minority charge carriers. For n-type semiconductor material, the majority charge carriers are electrons. The minority charge carriers in n-type semiconductor material are holes. The reverse applies to p-type semiconductor material for which the majority carriers are holes while the minority carriers are electrons.

A piece of doped semiconductor material not subjected to any external electrical potential difference (voltage) is electrically neutral. The concentration (or density) of majority charge carriers in doped electrically neutral semiconductor material is much higher, typically many orders of magnitude higher, than the concentration of minority charge carriers in the electrically neutral semiconductor material.

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A depletion layer, sometimes referred to as a space-charge layer, is a doped semiconductor region substantially devoid of mobile majority charge carriers. For instance, when a depletion layer is formed in n-type semiconductor material for which the n-type dopant atoms are electron donors, the depletion layer is substantially devoid of electrons, the majority charge carriers for electrically neutral n-type semiconductor material. A depletion layer formed in p-type semiconductor material whose p-type dopant

atoms are electron acceptors is substantially devoid of holes, the mobile majority charge carriers for electrically neutral p-type semiconductor material.

The bound charges formed by the singly charged dopant atoms in a depletion layer cause the layer to be positively charged, in the case of n-type semiconductor material, or negatively charged, in the case of p-type semiconductor material. Because the bound charges are immobile, they cannot conduct electricity. In the absence of a suitable electrical potential difference that causes charge to be injected into a depletion layer, the substantial absence of majority charge carriers in a depletion layer causes it to have a very weak capability for conducting electricity. Hence, a depletion layer is effectively an electrical insulator.

An inversion layer is a thin doped semiconductor region in which the concentration of minority charge carriers is considerably greater than what would occur in otherwise identical electrically neutral semiconductor material. Taking note of the fact that mobile charge carriers, both majority carriers and minority carriers, are continually being thermally created in semiconductor material, an inversion layer forms in a thin portion of a depletion layer, e.g., along the interface between the depletion layer and a region of electrically insulating material, when an electrical potential difference is applied across the semiconductor material in such a way as to attract minority charge carriers to the semiconductor region that constitutes the inversion layer.

For n-type semiconductor material whose majority charge carriers are electrons, the mobile charge carriers in an inversion layer formed in the n-type semiconductor material are mainly holes. The opposite occurs in p-type semiconductor material whose majority charge carriers are holes. That is, the mobile charge carriers in an inversion layer formed in the p-type semiconductor material are mainly electrons. Because the mobile charge carriers in an inversion layer formed in a piece of doped semiconductor material consist mainly of minority carriers for that doped semiconductor material, the conductivity type of the doped semiconductor region which forms the inversion layer is effectively inverted from the conductivity type of the electrically neutral portion(s) of the doped semiconductor material.

An inversion layer formed in a piece of doped semiconductor material is commonly considered to be in weak inversion when the concentration of minority charge carriers in the inversion layer is less than the net concentration of dopant atoms in the inversion layer. Strong inversion arises when the concentration of minority carriers in the inversion layer is greater than the net concentration of dopant atoms in the inversion layer. In either case, the presence of a substantial concentration of minority carriers enables the inversion layer to conduct electricity quite well. Accordingly, an inversion layer is effectively an electrical conductor.

Nowhere does Sakai mention inversion or in any way indicate that an inversion layer is formed at any location in Sakai's MIS varactor. Applicant's Attorney notes, nonetheless, that an inversion layer could be formed in

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depletion layer 19 along the bottom of insulating layer 24 if appropriate voltages were applied to electrodes 16 - 18 and 25. Since (the illustrated portion of) depletion layer 19 is doped n-type, the charge carriers in such an inversion layer would mainly be holes, the minority carriers for n-type semiconductor material. The inversion layer would laterally terminate at p-type regions 14 and 15.

Even if Sakai's MIS varactor were operated under conditions that cause such an inversion layer to form, the inversion layer would appear at substantially single instances of time and would disappear at substantially single instances of time. Contrary to what is required by Claim 1, such an inversion layer in the MIS varactor would not comprise multiple variably appearing inversion portions. Likewise, Sakai's MIS varactor would not meet the requirement of Claim 1 that the inversion portions be characterized by different zero-point threshold voltages of like sign or that each inversion portion largely appear/disappear when the gate-to-body voltage passed through the corresponding zero-point threshold voltage with the plate-to-body voltage at zero.

Nor would Sakai's MIS varactor satisfy the requirement of Claim 1 that each inversion portion meet the plate region or/and be continuous with another inversion portion of lower zero-point threshold voltage than that inversion portion. Consequently, Sakai does not anticipate Claim 1.

Furthermore, the Examiner has analogized control electrode 16, bottom electrode 18, and capacitance reading electrode 25 of Sakai respectively to the plate, body, and gate electrodes of Claim 1. As mentioned above, Sakai measures the capacitance of the MIS varactor between capacitance reading electrode 25 and bottom electrode 18. That is, Sakai measures the capacitance between the electrodes analogized by the Examiner to the gate and body electrodes of Claim 1.

Sakai does not disclose any circuitry that actually utilizes any of Sakai's varactors. However, Sakai clearly intends to employ each of its varactors, including the MIS varactor, in some electronic circuitry. Since Sakai measures the capacitance of the MIS varactor between "gate" electrode 25 and "body" electrode 18, the circuitry that employs the MIS varactor would have a capacitance signal path in which gate electrode 25 and body electrode 18 are situated.

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In addition to the varactors characteristics, Claim 1 recites that the claimed structure includes "further electronic circuitry having a capacitance signal path for receiving the varactor to enable the further circuitry to perform an electronic function dependent on the varactor" and that "the plate and body electrodes" are "situated in the capacitance signal path". In particular, Claim 1 requires that the plate electrode be one of the electrodes situated in the capacitance signal path of the further electronic circuitry. Since "gate" electrode 25 and "body" electrode 18 would be situated in capacitance signal path of the circuitry that employs Sakai's MIS varactor, control electrode 16

(or 17) analogized by the Examiner to the plate electrode of Claim 1, would not be in the capacitance signal path of that circuitry. Sakai therefore fails to explicitly or inherently meet the requirement of Claim 1 that the plate electrode be in the capacitance signal path. This is a further reason why Sakai does not anticipate Claim 1.

Similarly repeated below, for the Examiner's convenience, are the remarks presented on pages 31 and 32 of the June 2004 Amendment as to why Sakai does not anticipate Claim 39:

> Moving to independent Claim 39, it is directed to a structure containing a varactor in which a surface depletion region of a body region extends along a gate dielectric layer below a gate electrode. Claim 39 specifies that the surface depletion region comprises "multiple surface depletion portions of different respective average net dopant concentrations" and that each of the surface depletion portions meets the plate region or/and is "continuous with a surface depletion portion more lightly doped than that surface depletion portion".
>
> A section of depletion layer 19 in Sakai's MIS varactor extends along insulating layer 24 below capacitance reading electrode 25. This section of layer 19 does constitute a surface depletion region. However, nowhere does Sakai disclose or in any way suggest that depletion layer 19, or the surface depletion section extending along insulating layer 24 below electrode 25, consists of multiple surface depletion portions of different average net dopant concentrations. Nor is it inherent that depletion layer 19, or the indicated surface depletion section, consists of multiple surface depletion portions of different average net dopant concentrations.
>
> The variation in the thickness of depletion layer 19 in Sakai's MIS varactor arises from geometrical factors and/or the voltages applied to electrodes 16 - 18 and 25, not from configuring layer 19, or the surface depletion section extending along insulating layer 24 below electrode 25, as multiple surface depletion portions of different average net dopant concentrations. Sakai fails to meet the limitation of Claim 39 that the surface depletion region comprise multiple surface depletion portions of different average net dopant concentrations. Consequently, Sakai does not anticipate Claim 39.

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Similar to Claim 1, Claim 39 also recites that the claimed structure includes "further electronic circuitry having a capacitance signal path for receiving the varactor to enable the further circuitry to perform an electronic function dependent on the varactor" and that "the plate and body electrodes" are "situated in the capacitance signal path". For the reasons presented above in connection with the further electronic circuitry of Claim 1, Sakai does not explicitly or inherently meet the requirement of Claim 39 that the plate electrode be situated in the capacitance signal path of electronic circuitry the

utilizes the recited varactor. This is another reason why Sakai does not anticipate Claim 39.

Summary

In short, all of pending Claims 1 - 60 and 69 - 94 have been shown to be patentable over the applied art. Accordingly, Claims 1 - 60 and 69 - 94 should be allowed so that the application may proceed to issue.

Please telephone Applicant's Attorney at 650-964-9767 if there are any questions.

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